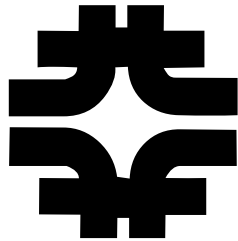


# On Proton Lifetimes at 150, & Proton Emittance Growth at 980



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Fermilab

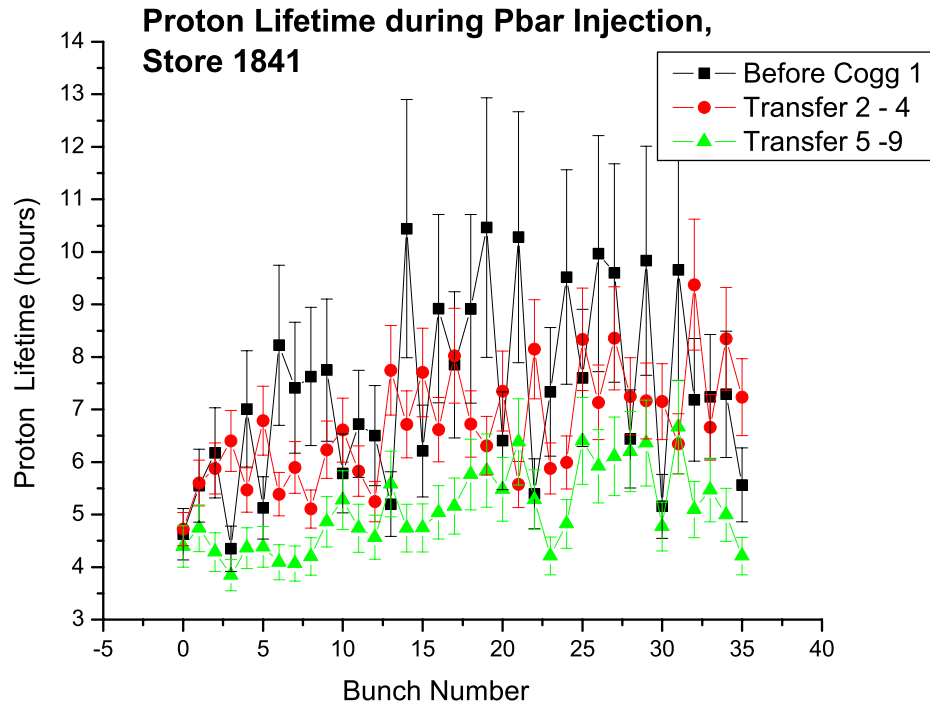
*November 1 2002*

## Suggested by Tanaji Sen, Vladimir,..:

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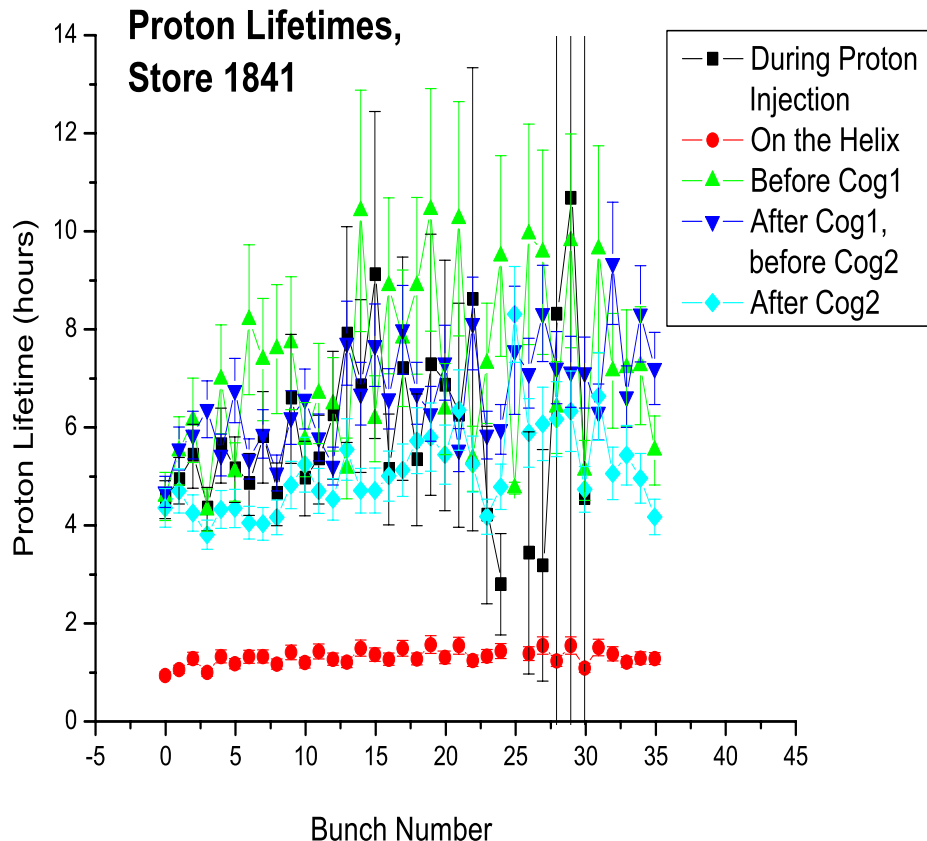
- We have noticed that the pbar beam “stabilizes” the proton beam. That is, 36x36 are somewhat easier to bring up to 980, and through squeeze, than 36x0 store, for a given proton current. Do we have other, quantitative indication of pbar- induced phenomena on the proton?
- For instance, does the proton life at 150 changes when we inject the pbars ?
- Do we understand the mechanism of proton emittance growth during the store, and transverse proton losses?

# Proton Lifetime, from FBIPNG / D44



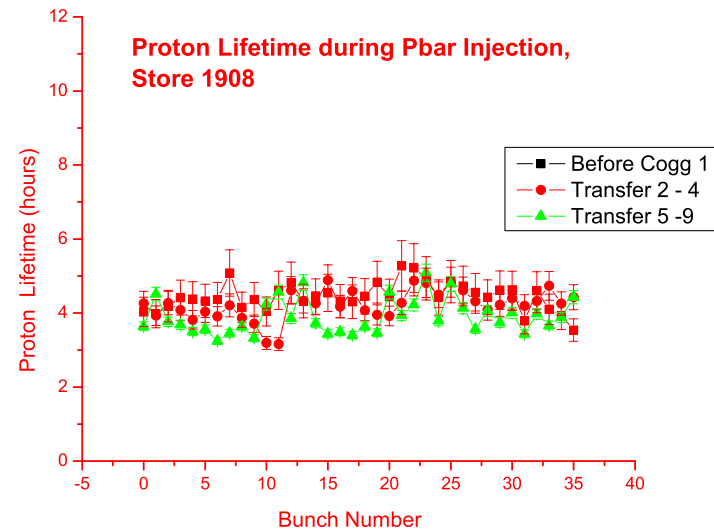
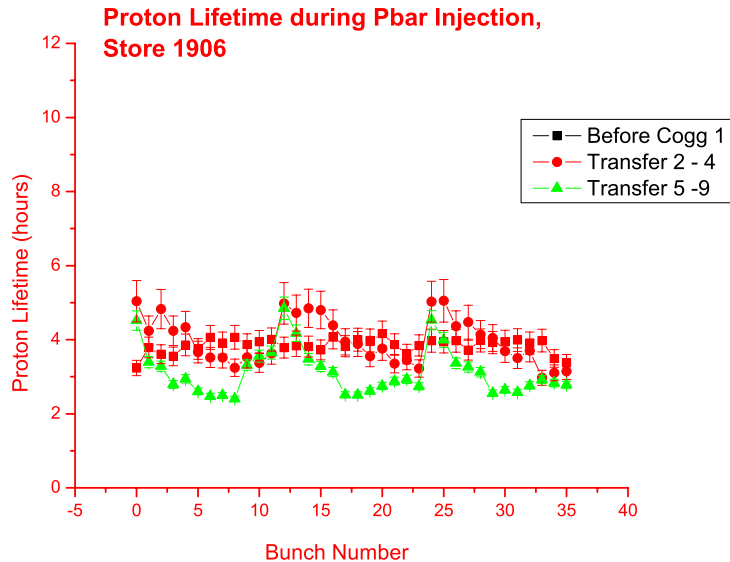
- The D44 “1Hz”, “tentatively archived”, has been used to measure the lifetime during pbar injection.
- The proton lifetime is not constant.
- For store 1841, the lifetime seems to decrease as we load more pbar. Do we see other systematic trends, store to store?

# Proton Lifetime, before/during pbar injection.



- On the central orbit, while we inject proton the lifetime is quite long ( $\sim$ many hours).
- It suddenly drops to  $\sim$ one hour when we move the beam on the helix.
- We stay there only for  $\sim 4 - 10$  min, typically, while the first pbar injection comes in.
- Then, the proton lifetime seems to climb back up to  $\sim 5$  hours.
- ➔ Did we simply shave the beam against a hard aperture, or did the pbar had something with it?

# Other stores..



The difference in lifetime between beginning and end of the pbar injection is, unfortunately, not reproducible. Note also that measuring a lifetime of about 4 hours with only a few minutes is not easy. Finally, for each pbar transfer, we of course have to fire the pbar kickers... Does this perturbs the proton beam?

# Status...

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Sorting this out will probably require more studies:

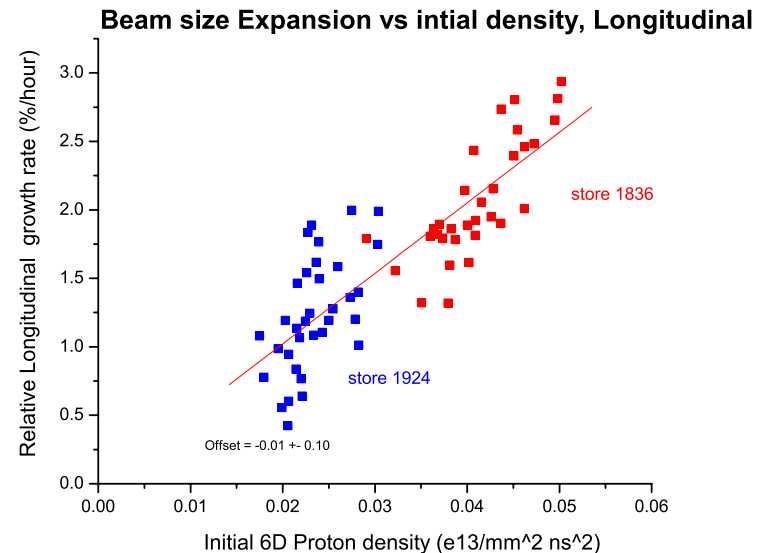
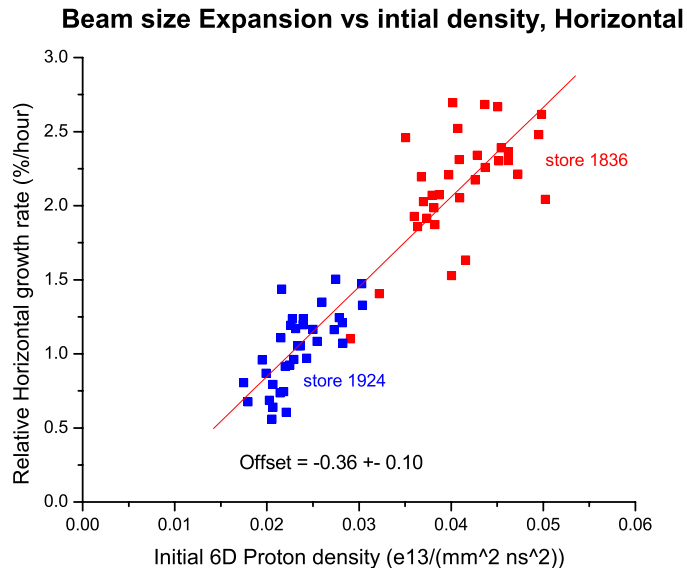
starting with no pbar in TeV : “Lost Stack” study, 36x0 stores:

- Vary the time we stay on the helix. Measure the lifetime versus time. Do we also have a non-linear lifetime on the helix? Where do the losses occurs?
- Do “dry pbar” injection : fire the TeV pbar kicker as if we were taking beam, while the MI does not send beam to us. Measure the proton lifetime while this is going on. Locate where losses occur.

Next, “not too dedicated”, study, 36x36 ..

Stay a bit longer on helix to let the proton shave itself off ?  
(An \$\$\$\$\$ study... )

# Proton Emittance growth at 980



The initial 6D beam density comes from a direct measurement of the SyncLite spot sizes, the bunch length. The relative growth rate is also measured by the SBD and the SyncLite. Note that these two detector are completely independent from each others.. These growth rates have been measured at the beginning of the store, measurement duration of 2.5 hours. Bunch with an excess of 0.8 MHz loss rate have been excluded.

# A lot of further analysis & calculation is needed..

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Although such plots are tantalizing evidence for intra-beam scattering, note that the slope in these plots do, sometimes on the store number! In addition, is this slope consistent (in magnitude) with expected IBS? So, this out will probably require more work (no studies yet!) :

Review IBS calculations and data, and discuss it. Pursue such studies:

- a. Does the relative growth rate depends on time (yes, but not need to document more systematically)
- b. Is this reproducible? (not quite: why are some stores better than others? )
- c. Vertical Plane ?
- d. Growth rate and loss rate ?
- e. Is this happening for pbar? What are the IBS prediction ?
- f. ....

Not strictly academical: if we succeed both at reducing the long.emittance and raise the intensity, this could be the limiting factor for store duration at high Luminosity !